UNIVERSITY COLLEGE of the FRASER VALLEY

UPAC FORM #2 (Page 1)

COURSE IMPLEMENTATION DATE:	September 1995
COURSE REVISED IMPLEMENTATION DATE:	September 2006
COURSE TO BE REVIEWED:	November 2009
(Four years after UPAC final approval date)	(MONTH YEAR)

OFFICIAL COURSE OUTLINE INFORMATION

Students are advised to keep course outlines in personal files for future use.

Shaded headings are subject to change at the discretion of the department and the material will vary - see course syllabus available from instructor

FACULTY/DEPARTMENT: **Faculty of Sciences, Health & Human Services/Physics**

COURSE NAME/NUMBER	FORMER COURSE NUMBER	UCFV CREDITS
PHYSICS 484		**3**

Nonlinear Physics

COURSE DESCRIPTIVE TITLE

CALENDAR DESCRIPTION:

This course is designed to introduce students to the exciting world of nonlinear physics. This is an important course because nonlinear and computational physics are modern topics that are at the cutting edge of research. The course introduces techniques that not only can be applied to physics, but to other disciplines; disciplines as diverse as economics and medicine. Computer algebra is introduced and used extensively to perform the symbolic computations, equation manipulations, simulations, animations, and model testing required by this course. Some mathematical methods include: the solving of nonlinear differential and difference equations, topological analysis, limit cycles, partial differential equations, and a variety of numerical techniques.

PREREQUISITES: Physics 221, Physics 381
PRE OR COREQUISITES: Physics 485

SYNONYMOUS COURSE(S)
(a) Replaces: **n/a** *(Course #)*
(b) Cannot take: **n/a** *(Course #)* for further credit.

SERVICE COURSE TO:
(Department/Program)
(Department/Program)

TOTAL HOURS PER TERM: **75**

STRUCTURE OF HOURS:

Lectures:	**75**	Hrs
Seminar:		Hrs
Laboratory:		Hrs
Field Experience:		Hrs
Student Directed Learning:		Hrs
Other (Specify):		Hrs

TRAINING DAY-BASED INSTRUCTION
LENGTH OF COURSE:
HOURS PER DAY:

MAXIMUM ENROLLMENT: **24**
EXPECTED FREQUENCY OF COURSE OFFERINGS: **once every two years**
WILL TRANSFER CREDIT BE REQUESTED? (lower-level courses only) ☐ Yes ☐ No
WILL TRANSFER CREDIT BE REQUESTED? (upper-level requested by department) ☒ Yes ☐ No
TRANSFER CREDIT EXISTS IN BCCAT TRANSFER GUIDE: ☐ Yes ☐ No

AUTHORIZATION SIGNATURES:

Course Designer(s): George McGuire
Chairperson: Gillian Mimmack *(Curriculum Committee)*
Department Head: Norm Taylor
Dean: Jackie Snodgrass
UPAC Approval in Principle Date:
UPAC Final Approval Date: December 14, 2005

LEARNING OBJECTIVES / GOALS / OUTCOMES / LEARNING OUTCOMES:

This course is designed to provide students with:

1. An appreciation of the importance of nonlinear phenomena in the everyday world;
2. Symbolic computational skills that are needed for employment in a technical society;
3. Useful problem solving and critical thinking skills;
4. The skills needed to tackle problems in a variety of non-scientific disciplines;
5. An understanding of the capabilities and limitations of symbolic computational software;
6. A skill which makes them employable.

METHODS:

This course will be presented using lectures, demonstrations, experiments, and computer simulations. Computer assisted instruction and learning is emphasized in this course. A major emphasis of this course is to provide the students with an opportunity to use a computer algebra system to gain confidence in their ability to manipulate and solve equations, test a model's predictions, and to simulate the model's behaviour.

PRIOR LEARNING ASSESSMENT RECOGNITION (PLAR):

Credit can be awarded for this course through PLAR (Please check:) ☒ Yes ☐ No

METHODS OF OBTAINING PLAR:

Departmental Review and/or Course Challenge

TEXTBOOKS, REFERENCES, MATERIALS:

[Textbook selection varies by instructor. An example of texts for this course might be:]

TEXT: Enns, McGuire, Nonlinear Physics with Maple for Scientists and Engineers, 2nd. Ed., Birkhauser, NY (2000)

REFERENCES:

1. Jackson, E. A., Perspectives of Nonlinear Dynamics, Vol. 1 and Vol. 2, Cambridge University Press, 1989, 1991
2. Moon, F. C., Chaotic and Fractal Dynamics, An Introduction for Applied Scientists and Engineers, Wiley, 1992
3. Hilborn, R. C., Chaos and Nonlinear Dynamics, Oxford University Press, 1994

SUPPLIES / MATERIALS:

STUDENT EVALUATION:

[An example of student evaluation for this course might be:]

Assignments	50%
Project	30%
Final	20%

COURSE CONTENT:

[Course content varies by instructor. An example of course content might be:]

Weeks 1 - 2: Interesting Nonlinear Systems
a. nonlinear mechanics (simple pendulum, eardrum, nonlinear damping, lattice dynamics)
b. competition phenomena (Volterra equations, fox rabies in Europe, laser beam competition)
c, nonlinear electrical phenomena
d. chemical oscillators
e. solitons

f. chaos

Weeks 3 - 4: Methods of Solutions
a. exactly solvable equations (i.e. Bernoulli, Riccati, elliptical integrals)
b. variation of parameters

Weeks 5 - 6: Topological Analysis and Graphical Solutions
a. types of singular points
b. graphical methods of solution

Week 7: Limit Cycles
a. oregonator model
b. first theorem of Bendixon
c. Poincare-Bendixon Theorem
d. Prigogine-Lefever Model

Week 8: Analysis Methods
a. perturbation method (Poisson's & Linstedt's)
b. Krylov-Bogoliubov Method
c. Ritz method
d. Galerkin method

Week 9: Forced Nonlinear Oscillators
a. iterative solution of Duffing's equation
b. nonlinear response curve
c. nonlinear damping
d. jump phenomena and hysteresis
e. subharmonic response

Week 10: Partial Nonlinear Differential Equations
a. Burger's Equation-Hopf-Cole transformation
b. elementary soliton calculations

Week 11: Inverse Scattering Transformation Method
a. Lax's formulation
b. one and two soliton formulas
c. general input shapes
d. Zakharov-Shabat/AKNS Approach

Week 12: Numerical Techniques
a. finite difference approximations
b. Special Methods
Euler, Modified Euler, Runge-Kutta, explicit method of solving PDE's

Week 13: Summary
a. review
b. summary of uses and importance of nonlinear physics
c. conclusion